Message Information

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From Matt Vespa <mvespa@biologicaldiversity.org>

To LisaP Jackson/DC/USEPA/US@EPA

cc

Subject Petition to Set Water Quality Critieria for Black Carbon Under the Clean Water Act

Message Body

Ms. Jackson,

Enclosed please find a petition filed by the Center for Biological Diversity pursuant to the Clean Water Act, 33 U.S.C. §§ 7401 et seq., its implementing regulations, and the Administrative Procedures Act, 5 U.S.C. § 553(e), to develop national water quality criteria for black carbon on sea ice and glaciers and take other actions as requested in the petition.

Thank you for your attention to this urgent matter. Please do not hesitate to contact me at mvespa@biologicaldiversity.org or (415) 436-9682 x309 concerning the petition.

A hard copy of the petition is being sent to you via Federal Express.

Sincerely,
Matt Vespa

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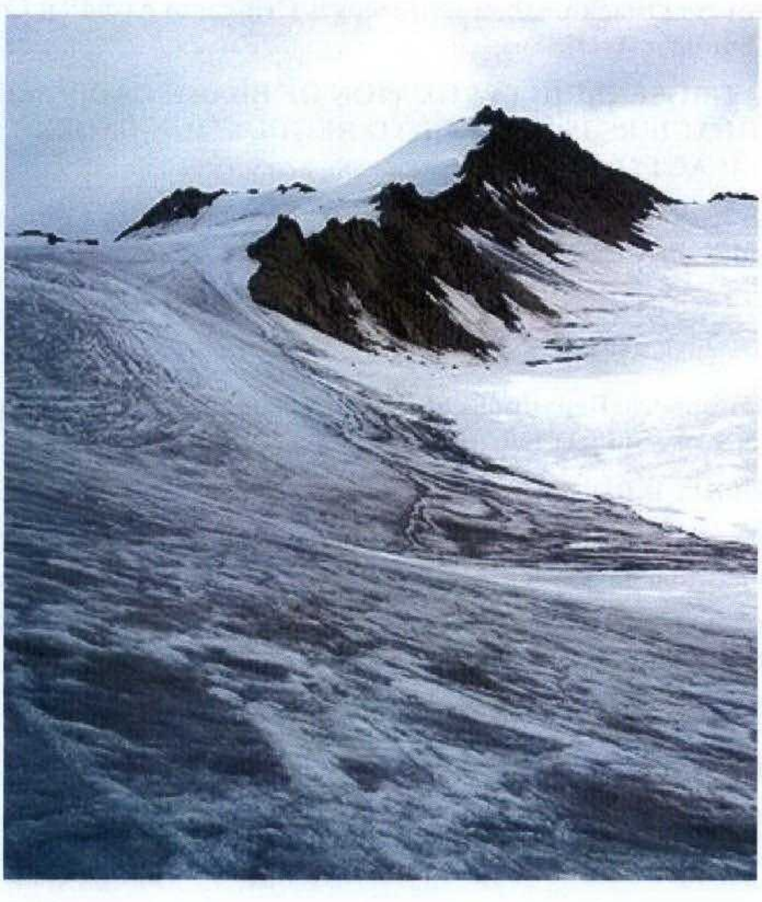
PETITION FOR WATER QUALITY CRITERIA FOR BLACK CARBON ON SEA ICE AND GLACIERS UNDER SECTION 304 OF THE CLEAN WATER ACT, 33 U.S.C. § 1314



BEFORE THE ENVIRONMENTAL PROTECTION AGENCY

February 22, 2010

TABLE OF CONTENTS

PETITION FOR WATER QUALITY CRITERIA FOR BLACK CARBON ON SEA ICE AND GLACIERS UNDER SECTION 404 OF THE CLEAN AIR ACT, 33 U.S.C. § 1314

I. EXECUTIVE SUMMARY

Arctic sea ice and glaciers are rapidly diminishing. At current trajectories, scientists predict that the Arctic Ocean could be ice-free in summer by 2030. Many of the glaciers still remaining in the continental United States are also projected to disappear within this timeframe. These catastrophic changes are not only the result of increased atmospheric concentrations of greenhouse gas emissions, but also from black carbon, an airborne particle generated from the incomplete combustion of fossil fuels, biofuels, and biomass. Black carbon has both a direct warming effect, by absorbing solar radiation in the atmosphere and converting it to heat radiation, and an indirect effect, by reducing the reflectivity (albedo) of snow and ice when deposited on these surfaces. Because it turns snow and ice darker, black carbon deposition accelerates the melt of sea ice and glaciers.

Because of black carbon's short atmospheric lifespan, reductions in black carbon emissions yield immediate benefits. Restoring snow and ice albedos to preindustrial levels would help stem the loss of sea ice and glaciers and buy critically needed time to achieve the deep reductions in carbon dioxide and other greenhouse gases that are ultimately necessary to preserve these important resources. However, the window of opportunity to act, like the sea ice, is shrinking rapidly.

The Center for Biological Diversity formally requests that the United States Environmental Protection Agency (EPA) initiate a rulemaking pursuant to the Clean Water Act, 33 U.S.C. § 1314(a), to address threats posed by black carbon. This Petition for rulemaking specifically requests that the EPA:

(1) Develop national water quality criteria pursuant to section 304(a)(1) stating that black carbon concentrations on sea ice and glaciers should not deviate measurably from preindustrial levels.

(2) Publish information on black carbon pursuant to section 304(a)(2) to guide states in identifying local sources of black carbon emissions and strategies for reducing those emissions.

As the nation's premier mechanism for protecting water quality, the Clean Water Act is designed to address water pollution - including degradation from the deposition of black carbon. Protection of sea ice and glaciers is required under the Clean Water Act. Sea ice forms off the coast of Alaska and is part of the "territorial seas" explicitly protected under the Act. Clean Water Act jurisdiction also extends to glaciers because glaciers are water bodies whose waters flow into traditional navigable waters. Protection of sea ice and glaciers also furthers the fundamental purpose of the Clean Water Act, which is "to restore and maintain the chemical, physical, and biological integrity of the

Nation's waters."[1] Sea ice and glaciers are essential components of the chemical, physical and biological integrity of the Arctic and/or downstream waters and the ecosystems of which they are a part.

The Clean Water Act is the nation's strongest law protecting our waters. Because black carbon is contributing to glacial retreat and loss of sea ice, EPA is required to address the impacts of black carbon on these vanishing resources. Therefore, it is incumbent upon EPA to develop and publish the criteria and information requested in this Petition.

II. PETITIONER

The Center for Biological Diversity is a nonprofit environmental organization dedicated to the protection of imperiled species and their habitats through science, education, policy, and environmental law. The Center's Climate Law Institute develops and implements legal campaigns to limit global warming pollution and prevent it from driving species extinct. The Center has over 225,000 members and online activists. The Center submits this Petition on its own behalf and on behalf of its members and staff with an interest in protecting the environment.

The contact for this Petition is:

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III. RIGHT TO PETITION

The right of an interested party to petition a federal agency is a freedom guaranteed by the first amendment: "Congress shall make no law … abridging the … right of people … to petition the Government for redress of grievances."[2] Under the Administrative Procedures Act (APA), all citizens have the right to petition for the "issuance, amendment, or repeal" of an agency rule.[3] A "rule" is the "whole or a part of an agency statement of general or particular applicability and future effect designed to implement, interpret, or prescribe law or policy."[4] In the present case, Petitioner seeks issuance of a new rule containing water quality criteria for black carbon. The issuance of

[1] Federal Water Pollution Control Act ("Clean Water Act") § 101(a); 33 U.S.C. § 1251(a) (2006).
[2] U.S. Const., amend I; *see also United Mine Workers v. Illinois State Bar Ass'n*, 389 U.S. 217, 222 (1967) (right to petition for redress of grievances is among most precious of liberties without which the government could erode rights).
[3] 5 U.S.C. § 553(e) (2006).
[4] 5 U.S.C. § 551(4) (2006).

new criteria under Section 304 is a non-discretionary duty under the Clean Water Act. EPA is required to respond to this petition: "Prompt notice shall be given of the denial in whole or in part of a written application, petition, or other request of an interested person made in connection with any agency proceeding."[5]

This Petition is enforceable under the citizen suit provision of the Clean Water Act.[6] The federal district courts of the United States have jurisdiction over a claim that the Administrator of the EPA has failed to perform a non-discretionary duty.[7] The APA also provides for judicial review of a final agency action and permits courts to compel agency action unlawfully withheld or unreasonably delayed.[8] The scope of review by the courts is determined by Section 706 of the APA.[9]

IV. SCIENTIFIC BACKGROUND ON BLACK CARBON

A. Black Carbon is Likely the Second Leading Cause of Global Warming After Carbon Dioxide

Increases in atmospheric concentrations of greenhouse gases are typically associated with global warming. However, aerosols are also an important and often overlooked contributor to climate change. Aerosols are small particles present in the atmosphere that affect climate change through either the reflection or absorption of solar radiation.[10] Light colored, reflective particles, such as sulfates, generally have a cooling effect on the climate.[11] In contrast, dark colored, light-absorbing particles, such as black carbon, have a direct warming effect on the climate by absorbing solar radiation in the atmosphere and converting it to heat radiation.[12] The International Panel on Climate Change (IPCC) estimates that the direct radiative forcing of black carbon is 0.34 Wm^{-2} [± 0.25].[13] A more recent estimate of the radiative forcing of black carbon is 0.9 Wm^{-2}, which is "as much as 55% of the forcing" due to carbon dioxide.[14] The strong warming effect of black carbon exceeds that due to methane, "suggesting that black carbon may be

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[5] 5 U.S.C. § 555(e) (2006).

[6] 33 U.S.C. § 1365 (2006).

[7] 33 U.S.C. § 1365(a)(2) (2006).

[8] 5 U.S.C. §§ 704, 706 (2006).

[9] 5 U.S.C. § 706 (2006).

[10] Piers Forster et al., *Changes in Atmospheric Constituents and Radiative Forcing, in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, CONTRIBUTION OF WORKING GROUP 1 TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 136 (S. Solomon et al. eds., 2007).

[11] Tami Bond & Haolin Sun, *Can Reducing Black Carbon Emissions Counteract Global Warming?*, 39 ENVTL. SCI. & TECH. 5921, 5921 (2005).

[12] Forster et al., *supra* note 10, at 163.

[13] *Id.* at 207. "Radiative forcing is a measure of how the energy balance of the Earth-atmosphere system is influenced when factors that affect climate are altered. Radiative forcing is usually quantified as the 'rate of energy change per unit area of the globe as measures at the top of the atmosphere' and is expressed in units of Watts per square meter. When radiative forcing is positive, the energy of the Earth-atmosphere system will ultimately increase, leading to a warming of the system." *Id.* at 136.

[14] V. Ramanathan & G. Carmichael, *Global and Regional Climate Changes Due to Black Carbon*, 1 NATURE GEOSCIENCE 221, 222 (2008).

the second most important component of global warming after CO_2 in terms of direct forcing."[15]

B. Black Carbon Deposition Accelerates the Melt of Sea Ice and Glaciers by Reducing the Reflectivity of Snow and Ice

In addition to its direct warming effect, black carbon has an indirect warming effect by reducing the reflectivity of snow and ice.[16] When black carbon falls on snow and sea ice surfaces, either on its own or within ice crystals or snow flakes, it darkens those surfaces, thereby contributing to the melting of snow and ice and the warming of air above both.[17] The direct and indirect warming effects of black carbon make it one of the most important contributors to the retreat of Arctic sea ice.[18] Snow and ice contaminated with black carbon heat the Arctic surface very efficiently due to strong Arctic temperature inversions and the insulating properties of snow.[19] In the spring, deposition of black carbon onto snow and ice yields a positive forcing that increases surface temperature by approximately 0.5°C.[20] During springtime in the Arctic, black carbon's direct warming effect on snow can be three times as strong as carbon dioxide.[21] Because of its combined heating of the Arctic atmosphere and of the surface, black carbon is believed to warm the Arctic more than any other agent except carbon dioxide.[22]

Black carbon has an even greater impact on seasonal snow and ice because it causes earlier exposure of underlying low-albedo surfaces (e.g., rock, soil, vegetation and

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[15] Mark Jacobson, *Strong Radiative Heating Due to the Mixing State of Black Carbon in Atmospheric Aerosols*, 409 NATURE 695, 695 (2001); Ramanathan & Carmichael, *supra* note 14, at 221. Because it is an aerosol and not a greenhouse gas, there is no standardized formula for developing global warming potentials (GWP) for black carbon. However, attempts to estimate the GWP of black carbon over a period of 100 years range from a GWP 90 – 2240 times that of carbon dioxide. *See* Mark Jacobson, *Correction to 'Control of Fossil Fuel Particulate Black Carbon and Organic Matter, Possibly the Most Effective Method of Slowing Global Warming,'* 110 J. GEOPHYSICAL. RES. D14105 (2005) (GWP BC – 90 - 190); Bond & Sun, *supra* note 11, at 5921 (GWP BC - 680); *EPA Black Carbon and Global Warming: Hearing Before the H. Comm. on Oversight and Gov't. Reform*, 110th Cong. 12-29 (2007) [hereinafter *Hearing*] (statement of Mark Z. Jacobson, Professor, Stanford University) (GWP BC - 2240).

[16] *See, e.g.*, James Hansen & Larissa Nazarenko, *Soot Climate Forcing via Snow and Ice Albedos*, 101 PROC. NAT'L ACAD. SCI. U.S. 423, 427 (2004), *available at* http://www.pnas.org/content/101/2/423.full.

[17] Ramanathan & Carmichael, *supra* note 14, at 222; *Hearing, supra* note 15, at 16 (statement of Mark Z. Jacobson).

[18] Ramanathan & Carmichael, *supra* note 14, at 224.

[19] *Hearing, supra* note 15, at 72 (statement of Charles Zender, Associate Professor, University of California at Irvine).

[20] P.K. Quinn et al., *Short-lived Pollutants in the Arctic: Their Climate Impact and Possible Mitigation Strategies*, 8 ATMOSPHERIC CHEMISTRY & PHYSICS 1723, 1731 (2008).

[21] *Hearing, supra* note 15, at 73 (statement of Charles Zender, Associate Professor, University of California at Irvine); *see also* M. Flanner et al., *Present-Day Climate Forcing and Response from Black Carbon in Snow*, 112 J. GEOPHYSICAL. RES. D11202 at 15 (2007) ("BC snowpack can provoke disproportionately large springtime climate response because the forcing tends to coincide with the onset of snowmelt, thus triggering more rapid snow ablation and snow-albedo feedback.").

[22] *Hearing, supra* note 15, at 73 (statement of Charles Zender, Associate Professor, University of California at Irvine).

ocean).[23] Over the course of the Arctic spring, black carbon-contaminated snow absorbs enough extra sunlight to melt earlier – weeks earlier in some places – than clean snow.[24] As snow and ice surfaces continue to warm, melt, darken and lose contrast with black carbon, the net warming effect of black carbon on the Arctic will decrease.[25] Thus, reducing black carbon now will have more of an impact than delaying reductions.

Black carbon's impact on the melting of snow and sea ice applies with equal force to the decrease in albedo of glaciers in montane regions and consequent accelerated melt-off. Black carbon depositions on Tibetan glaciers have been found to be a significant contributing factor to observed rapid glacier retreat.[26] By increasing surface melt on ice masses, black carbon triggers positive feedbacks because the resulting melt water spurs multiple radiative and dynamic feedback processes that accelerate ice disintegration.[27] Moreover, in the case of glaciers, by increasing water flow through crevasses and moulins, black carbon speeds freeze-thaw ice break-up and lubrication of the ice sheet base.[28]

Pristine Antarctic regions have been found to contain black carbon concentrations of 0.1-0.3 ppbw (parts per billion by weight), two orders of magnitude less than the Arctic.[29] Notably, black carbon amounts of 3 ppbw were found 1 km downwind of the South Pole station, where the station's power plant and aircraft operations were a suspected source.[30] Snow samples in the 1980s, including sites in Alaska and on sea ice in the central Arctic, yielded typical black carbon amounts of 10-50 ppbw.[31] While black carbon emissions may have fallen in the 1990s due to the economic collapse of the former Soviet Union, reduced black carbon emissions are not necessarily permanent in the face of possible economic recovery, increased shipping in the opening Northwest and Northeast Passages, regional hydrocarbon resource development, and increased use of diesel-powered vehicles.[32] Measurements in the Alps revealed black carbon concentrations as large as 100 ppbw, enough to reduce the visible albedo by approximately 10% and double absorption of sunlight.[33] However, because of the positive feedbacks resulting from black carbon deposition, much smaller concentrations of black carbon perturb snowmelt. In today's warmer climate, very small concentrations

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[23] Joseph McConnel et al., *20th-Century Industrial Black Carbon Emissions Altered Arctic Climate Forcing*, 317 SCIENCE 1381, 1383 (2007).
[24] *Hearing, supra* note 15, at 72 (statement of Charles Zender, Associate Professor, University of California at Irvine).
[25] *Hearing, supra* note 15, at 71 (statement of Charles Zender, Associate Professor, University of California at Irvine).
[26] Baiqing Xu et al., *Black Soot and the Survival of Tibetan Glaciers*, 106 PROC. NAT'L ACAD. SCI. U.S. 22114 (2009), *available at* http://www.pnas.org/content/106/52/22114.full.
[27] Hansen & Nazarenko, *supra* note 16, at 427.
[28] *Id.*
[29] *Id.* at 424.
[30] *Id.*
[31] *Id.* at 423.
[32] *Id.* at 424.
[33] *Id.* at 427.

of black carbon impurities (~ 10 ppb) are triggering astonishingly large ice-albedo warming.[34]

C. Sources of Black Carbon

Black carbon is released into the atmosphere from the incomplete combustion of fossil fuels, biofuels and biomass. Black carbon emissions result mainly from four source categories: (1) diesel engines for transportation and industrial use; (2) residential solid fuels such as wood and coal; (3) open forest and savanna burning, both natural and initiated by humans for land clearing; and (4) industrial processes, usually from small boilers.[35]

The relative contribution of black carbon from combustion sources varies considerably with source type. Since black carbon is emitted with other particulates, including some that are light-reflecting and therefore have a cooling effect, fuel source and burning process will determine the net warming effect of combustion. When fossil fuels, such as oil and coal, are incompletely combusted (i.e., not completely oxidized to carbon dioxide), black carbon tends to be formed in much larger amounts than organic carbon.[36] For this reason, soot from diesel combustion usually appears black because it contains a high fraction of black carbon, which absorbs all colors of visible light. Soot from biofuel is brownish because it contains a higher ratio of organic carbon to black carbon than diesel soot.[37] When biomass fuels, such as wood, are incompletely combusted, organic carbon is formed in greater amounts than black carbon.[38] Organic carbon is generally thought to have a direct cooling effect because it reflects incoming sunlight. Thus, black carbon mitigation should take into account the co-effects of associated organic carbon reductions.[39] An optimal decrease in the warming effects of aerosols can be achieved by targeting subsectors, such as diesel combustion, which emit a relatively large percentage of black carbon.[40]

Because of its low contrast with the snow and ice-covered surfaces, the general cooling effect of bright aerosols such as sulfates and organic matter that are emitted along with black carbon have relatively little, if any, cooling effect on snow and ice-covered

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[34] *Hearing, supra* note 15, at 74 (statement of Charles Zender, Associate Professor, University of California at Irvine).

[35] *Id.* at 33 (statement of Tami Bond, Assistant Professor, University of Illinois at Urbana-Champaign).

[36] MARK BAHNER ET AL., RTI INTERNATIONAL, USE OF BLACK CARBON AND ORGANIC CARBON INVENTORIES FOR PROJECTIONS AND MITIGATION ANALYSIS 1, http://www.epa.gov/ttn/chief/conference/ei16/session3/k.weitz.pdf (last visited Feb. 2, 2010). Large coal-fired plants do not emit a significant amount of black carbon because the very high temperatures and efficient mixing of air and fuel readily oxidize any fine carbon particles leaving the combustion zone. It is primarily mineral matter that escapes – which is either captured in a particulate control device or passes through into the atmosphere. D.G. Streets et al., *On the Future of Carbonaceous Aerosol Emissions*, 109 J. GEOPHYSICAL RES. D4212 at 2 (2004).

[37] *Hearing, supra* note 15, at 15 (statement of Mark Z. Jacobson, Professor, Stanford University).

[38] Bahner et al., *supra* note 36, at 1.

[39] *Id.* at 2.

[40] Dorothy Koch et al., *Global Impact of Aerosols from Particular Source Regions and Sectors*, 112 J. GEOPHYSICAL RESEARCH D02205 at 18 (2007).

regions.[41] For example, the International Panel on Climate Change reports that emissions from biomass burning, which usually have a negative forcing, have a positive forcing over snow fields in areas such as the Himalayas.[42]

Due to its short atmospheric lifespan, black carbon is not globally well-mixed. In most years, 70-90% of Arctic black carbon appears to stem from fuel combustion.[43] Black carbon emissions deposited in the Arctic largely originate from Northern Eurasia, North America, and Asia.[44] However, emissions of black carbon occurring within the Arctic have a disproportionately larger impact on Arctic warming than emissions generated elsewhere.[45] As Arctic ice melts and shipping activity increases, emissions originating within the Arctic are expected to rise. In the Western United States, much of the black carbon deposition onto snow comes from populated regions west of the mountains, in particular from vehicular and ship emissions.[46] Thus, "reductions in local emissions, which would provide an increase in snow albedo, could [partially] alleviate early snowmelt and reduce runoff in late winter and early spring caused by the global climate change."[47]

D. Strategies for Reducing Black Carbon Emissions

Based on the composition of major sources of black carbon emissions, measures to reduce black carbon should target sources that emit a high percentage of black carbon in comparison to cooling aerosols, such as emissions resulting from diesel combustion. Black carbon emissions emitted in the Arctic merit focused targeting because they have a disproportionate impact of Arctic warming and loss of sea ice. In addition, because sources that may typically result in negative forcing such as biomass burning can cause local positive forcing when proximate to snow and ice, reduction in emissions from these sources should also be considered. Although the United States has made substantial strides in regulating emissions from diesel combustion on public health grounds, thereby reducing black carbon, the United States has significant room to reduce black carbon emissions further. Recently summarized "no regrets" targets to mitigate the climate impacts of black carbon include: (1) diesel combustion in on-road heavy-duty vehicles,

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[41] *Hearing, supra* note 15, at 72 (statement of Charles Zender, Associate Professor, University of California at Irvine).

[42] V. Ramaswamy et al., *Radiative Forcing of Climate Change*, *in* CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS, CONTRIBUTION OF WORKING GROUP 1 TO THE THIRD ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 349, 397 (S. Solomon et al. eds., 2001) ("While the radiative forcing is generally negative, positive forcing occurs in areas with a very high surface reflectance such as desert regions in North Africa, and the snow fields of the Himalayas.").

[43] *Hearing, supra* note 15, at 71 (statement of Charles Zender, Associate Professor, University of California at Irvine).

[44] Quinn et al., *supra* note 20, at 1732.

[45] *Id.*

[46] Yun Qian et al., *Effects of Soot-Induced Snow Albedo Change on Snowpack and Hydrological Cycle in Western United States Based on Weather Research and Forecasting Chemistry and Regional Climate Simulations*, 114 J. GEOPHYSICAL. RES. D03108 at 2 (2009).

[47] D. WALISER, ET AL., SIMULATING THE COLD SEASON SNOWPACK: THE IMPACT OF SNOW ALBEDO AND MULTI-LAYER SNOW PHYSICS vi (2009), http://www.energy.ca.gov/2009publications/CEC-500-2009-030/CEC-500-2009-030-F.PDF.

off-road engines, and commercial shipping, especially near the Arctic; (2) near-Arctic biomass burning from forest fires and controlled agricultural fires; (3) near-glacier emissions of biofuel burning in residential heating and cooking; and (4) low-sulfur coal combustion in residential heating and cooking and industrial brick kilns in the developing world.[48]

Reducing within-Arctic emissions of black carbon (e.g. generators) and implementing emission controls on marine vessels operating within Arctic waters, particularly in light of the likely increase in shipping activity as the snow/ice pack decreases, will be required to reduce Arctic warming.[49] The replacement of marine residual oil with cleaner fuels, such as marine gas oil and marine diesel oil, will directly impact the black carbon, particulate organic matter, and sulfates attributed to ships.[50] Strategies to address black carbon emissions from ships also include operational measures like speed controls and shore-power electrification in port.[51] By promulgating regulations in response to the three Clean Air Act petitions that the Agency has before it to limit greenhouse gas and black carbon emissions from ships, and by mandating cleaner fuels for ships seeking to dock at U.S. ports, EPA can achieve significant reductions in the emissions of black carbon and other climate change pollutants.[52]

Recent EPA regulations on diesel emissions are expected to significantly reduce black carbon emissions from new heavy-duty vehicles. However, many of the standards in these rules do not phase in fully for new engines until 2015, with benefits accruing incrementally over a long period due to the slow turnover of older engines. Moreover, with the exception of rebuilt heavy duty engines, the rules do not require any additional black carbon emissions reductions in the existing, or "legacy," fleet of diesel vehicles, which have long life spans. Requiring regular vehicle emissions test, retirement, or retrofitting (e.g. particulate traps), including penalties for failing to meet air quality emissions standards, and heightened penalties for on-the-road "super-emitting" vehicles can achieve critically needed black carbon reductions from existing diesel powered vehicles. The EPA could also reduce black carbon emissions from off-road engines by responding to petitions for a rulemaking to reduce greenhouse pollution from these engines.[53]

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[48] INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION, A POLICY-RELEVANT SUMMARY OF BLACK CARBON CLIMATE SCIENCE AND APPROPRIATE EMISSION CONTROL STRATEGIES 8 (2009) [hereinafter *ICCT*], http://www.theicct.org/documents/0000/1022/BC_policy-relevant_summary_Final.pdf

[49] Quinn et al., *supra* note 20, at 1732.

[50] James Corbett et al., *Mortality from Ship Emissions: A Global Assessment*, 44 ENVTL. SCI. & TECH. 8512, 8513 (2007).

[51] *ICCT*, *supra* note 48, at 8.

[52] The EPA received petitions from Earthjustice, Oceana, Friends of the Earth, and the Center for Biological Diversity, a second petition from the State of California, and a third petition from the South Coast Air Quality Management District.

[53] The EPA received two petitions to regulate greenhouse emissions from nonroad engines and vehicles, the first from the States of California, Connecticut, Massachusetts, New Jersey and Oregon and Pennsylvania's Department of Environmental Protection, and the second from the Western Environmental Law Center on behalf of the International Center for Technology Assessment, Center for Food Safety, and Friends of the Earth.

E. Reducing Black Carbon Emissions is Critical to Avoiding Complete Loss of Summer Arctic Sea Ice

While reductions in carbon dioxide pollution are the backbone of any meaningful effort to mitigate the impacts of global warming, even if swift and deep reductions in carbon dioxide emissions are made, given the long lifetime of carbon dioxide in the atmosphere, these reductions may not be achieved in time to prevent the complete loss of summer sea ice in the Arctic and U.S. glaciers. Because black carbon emitted today will largely leave the atmosphere in a month or less, reducing black carbon emissions reduces warming within weeks.[54] Major cuts in black carbon emissions could slow the effects of climate change for a decade or two, buying policy makers more time to cut carbon dioxide emissions and potentially avoid irreversible effects of global warming.[55] Thus, restoration of snow albedos to levels approaching pristine pre-industrial values has the double benefit of reducing global warming and pushing back the point at which dangerous anthropogenic interference with the climate occurs.[56]

V. THE ATMOSPHERIC DEPOSITION OF BLACK CARBON ON SEA ICE AND GLACIERS IS SUBJECT TO REGULATION UNDER THE CLEAN WATER ACT

A. Sea Ice and Glaciers are Waters of the United States Afforded Protection Under the Clean Water Act

1. Sea ice

Sea ice is frozen seawater that floats on the ocean surface. Blanketing millions of square kilometers, sea ice forms and melts with the polar seasons, affecting both human activity and biological habitat. Arctic sea ice approaches its annual maximum in February.[57] In February 2009, sea ice extended along the northern and western shores of Alaska.[58] However, the monthly average sea ice extent for February 2009 was the fourth lowest in the satellite record, with February 2005 having the lowest extent, February 2006 the second lowest, and February 2008 the third lowest. Including 2009, the downward linear trend in February sea ice extent over the satellite record stands at -2.8 percent per decade.[59] Arctic sea ice reaches its minimum extent in September. Sea ice extent in 2009 was the third lowest since the start of the satellite record in 1979, with the past five years having the five lowest sea ice extents on record.[60] Nearly 40 percent of the sea ice area that was present in the 1970s was lost by 2007, the lowest year on

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[54] *See, e.g.*, *Hearing, supra* note 15, at 17 (statement of Mark Z. Jacobson, Professor, Stanford University).

[55] *Id.* at 53 (statement of V. Ramanathan, Professor, University of San Diego).

[56] Hansen & Nazarenko, *supra* note 16, at 423.

[57] National Snow & Ice Data Center, Arctic Sea News & Analysis, *Ice Extent Reaches Annual Maximum* (2009), http://nsidc.org/arcticseaicenews/2009/030309.html.

[58] *Id.*

[59] *Id.*

[60] Press Release, National Snow & Ice Data Center, Arctic Sea Ice Extent Remains Low; 2009 Sees Third-Lowest Mark (Oct. 6, 2009), *available at* http://nsidc.org/news/press/20091005_minimumpr.html.

record.[61] The observed summertime melting of Arctic sea ice has far exceeded the worst-case projections of climate models in the Fourth Assessment Report of the International Panel on Climate Change.[62] Scientists now predict that a seasonally ice-free Arctic Ocean could be realized by 2030.[63]

Protection of sea ice falls within the jurisdiction of the Clean Water Act because the Act explicitly encompasses protection of territorial seas off the coast of Alaska where sea ice seasonally forms. "Navigable waters" is defined under the Act as "the waters of the United States, including the territorial seas."[64] "Territorial seas" is in turn defined as the "belt of the seas measured from the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters, and extending seaward a distance of three miles."[65] In addition, Section 304(a)(2) requires EPA to develop and publish information "on the factors necessary to restore and maintain the chemical, physical, and biological integrity of all navigable waters, ground waters, waters of the contiguous zone, and *the oceans*."[66]

While there has been little explicit discussion to date of specific protection for water in its solid form under the Act, courts have not distinguished between discharges of pollutants onto ice or water when enforcing the Clean Water Act.[67] For purpose of the Clean Water Act, a "navigable water" need not be navigable in fact to be afforded the protections of the Act.[68] Indeed, in passing the Clean Water Act, Congress did not intend to use the term "navigable waters" in the traditional sense, but to "extend the coverage of the act as far as permissible under the commerce clause."[69] Accordingly, there is no legitimate basis to withhold Clean Water Act protection to sea ice because it is a solid.

Protection of sea ice also furthers the purpose of the Clean Water Act, which is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[70] Sea ice is a fundamental component of the Arctic marine ecosystem. For example, the volume and timing of sea ice melt is intimately connected to the chemical, physical and biological integrity of Arctic waters. Sea ice impacts the physical integrity of Arctic waters through alterations in temperature and light. The Arctic food web is

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[61] WORLD WILDLIFE FUND INT'L, ARCTIC CLIMATE FEEDBACKS: GLOBAL IMPLICATIONS 8 (Martin Sommerkorn & Susan Joy Hassol eds., 2009).

[62] UNIV. OF NEW SOUTH WALES RESEARCH CENTRE, THE COPENHAGEN DIAGNOSIS, UPDATING THE WORLD ON THE LATEST CLIMATE SCIENCE 31 (2009); WORLD WILDLIFE FUND INT'L, *supra* note 61, at 8.

[63] K. Stoeve et al, *Arctic Sea Ice Extent Plummets in 2007*, 89 EOS 13, 14 (Jan. 2008); *see also* M. Wang & J.E. Overland, *A Sea Ice Free Summer Arctic Within 30 Years?*, 36 GEOPHYSICAL. RES. LETTERS L07502 (2009) (predicting near ice-free Arctic by 2037).

[64] Clean Water Act § 502(7), 33 U.S.C. § 1362(7) (2006).

[65] Clean Water Act § 502(8), 33 U.S.C. § 1362(8) (2006).

[66] Clean Water Act § 304(a)(2), 33 U.S.C. § 1314(a)(2) (2006) (emphasis added).

[67] *See, e.g., United States v. Hamel*, 551 F.2d 107 (6th Cir. 1977) (affirming conviction for willful discharge of gasoline onto ice overlying lake).

[68] *See, e.g.,* EPA & Army Corps of Engineers, *Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States & Carabell v. United States* (Dec. 2, 2008).

[69] *Quivira Mining Co. v. U.S. Envtl Prot. Agency*, 765 F.2d 126, 130 (10th Cir. 1985) (citing *United States v. Texas Pipe Line Co.*, 611 F.2d 345, 347 (10th Cir. 1979).

[70] Clean Water Act § 101(a), 33 U.S.C. § 1251(a) (2006).

delicately balanced to take advantage of the seasonal timing of sea ice melt. When sea ice melts, ocean temperature and light increase, with a consequent increase in photosynthesis by phytoplankton. Phytoplankton are a food source for zooplankton that rise from deeper waters at specific times in the spring to feed. If sea ice melts early, the coupling between photosynthetic production and zooplankton demand becomes uncoupled.[71] This trophic mismatch has reverberating consequences throughout the food web. Furthermore, warmer waters that are less saline as a result of melted sea ice become more stratified so that less nutrient cycling occurs between the surface and deep waters, causing further adverse impacts to the Arctic food web.[72]

The chemical integrity of the oceans is also powerfully influenced by sea ice dynamics. The volume of sea ice melt has direct impacts on ocean acidification. Ocean acidification refers to the decrease in ocean pH that occurs when oceans absorb carbon dioxide from the atmosphere. As pH decreases, carbonate concentrations also decrease. Carbonate and calcium are essential for many organisms, such as plankton and shellfish, to form their shells. One of the common forms of calcium carbonate is aragonite, and the cold waters of the Arctic tend to have lower concentrations of aragonite than mid-latitude oceans.[73] Aragonite undersaturation is exacerbated with the loss of sea ice through multiple mechanisms. First, when sea ice melts there is an influx of freshwater that causes a reduction in salinity and total alkalinity, which in turn reduces carbonate concentrations.[74] Second, sea ice tends to have a lower concentration of dissolved inorganic carbon, which also intensifies ocean aragonite undersaturation when meltwater enters the oceans.[75] Third, sea ice cover reduces the surface of the ocean that is exposed to the air. Because carbon dioxide exchange occurs at the interface of the sea and air, when more surface ocean is exposed with sea ice melt, more carbon dioxide is absorbed by the oceans.[76]

Besides the extensive biological impacts of the chemical and physical status of the oceans, sea ice itself also confers exceedingly important ecological benefits. Krill, an important food source for many marine organisms including cetaceans, overwinter in sea ice, and krill availability is directly correlated to ice extent.[77] For many marine mammals

[71] K.L. Laidre et al., *Quantifying the Sensitivity of Arctic Marine Mammals to Climate-Induced Habitat Change*, 18 ECOLOGICAL APPLICATIONS S97, S99 (2008); A.S. Hansen et al., *Impact of Changing Ice Cover on Pelagic Productivity and Foodweb Structure in Disko Bay, West Greenland: A Dynamic Model Approach*, 50 DEEP SEA RESEARCH I 171, 182 (2003).

[72] N.R. Bates & J.T. Mathis, *The Arctic Ocean Marine Carbon Cycle: Evaluation of Air-Sea CO_2 Exchanges, Ocean Acidification Impacts and Potential Feedbacks*, 6 BIOGEOSCIENCES 2433, 2448 (2009).

[73] V.J. Fabry et al., *Impacts of Ocean Acidification on Marine Fauna and Ecosystem Processes*, 65 INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA (ICES) JOURNAL OF MARINE SCIENCES 414, 415 (2008).

[74] M. Yamamoto-Kawai et al., *Aragonite Undersaturation in the Arctic Ocean: Effects of Ocean Acidification and Sea Ice Melt*, 326 SCIENCE 1098, 1099 (2009).

[75] *Id.*

[76] *Id.*; Bates & Mathis, *supra* note 72 at 2446.

[77] K.F. Drinkwater et al., *On the Processes Linking Climate to Ecosystem Changes*, 79 JOURNAL OF MARINE SYSTEMS 374, 378 (2010).

sea ice habitat is as important as aquatic habitat.[78] For instance, narwhals depend on winter sea ice for foraging.[79] Pinnipeds such as walrus and seals also depend on sea ice for foraging as well as breeding and resting.[80] Polar bears depend on sea ice as hunting platforms as well and denning and whelping.[81] Finally, sea ice supports an abundant microbial and algal ecosystem within the ice matrix.[82] This intra-ice ecosystem productivity provides food for small amphipods that live under the ice, which in turn are food for diving birds and cod.[83]

Adverse impacts resulting from the accelerated loss of Arctic sea ice extend well beyond the Arctic Ocean and its coast. By reflecting the sun's energy back into space, sea ice is an effective insulator, preventing heat in the Arctic Ocean from escaping upward and warming the lower atmosphere.[84] The decline of sea ice amplifies warming in the Arctic, which in turn has major implications for temperature patterns over adjacent, permafrost-dominated land areas and for weather patterns across the Northern Hemisphere.[85] Rapid retreat of Arctic sea ice is predicted to accelerate warming 1,500 kilometers inland throughout Alaska, Canada and Russia.[86] During rapid ice retreat, the rate of inland warming could be more than three times that previously suggested by global climate models.[87] Higher temperatures will thaw out extensive expanses of permafrost, resulting in the potential release of methane and carbon dioxide that are currently frozen in Arctic soils thereby further accelerating additional warming.[88] Additional warming in the Arctic resulting from the loss of sea ice will also affect weather patterns by altering atmospheric circulation patterns and, through it, weather patterns affecting transportation, agriculture, forestry and water supplies.[89] Loss of sea ice in the Arctic Ocean will therefore have serious repercussions as climactic feedbacks resulting from higher temperatures accelerate, the timing of the seasons is altered, and shifting circulation patterns cascade through the Arctic and beyond.

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[78] See, e.g., Laidre *supra* note 71; E. Post et al., *Ecological Dynamics Across the Arctic Associated with Recent Climate Change*, 325 SCIENCE 1355, 1355 (2009).

[79] Laidre, *supra* note 71 at S101.

[80] *Id.*; Drinkwater, *supra* note 77.

[81] *Id.*

[82] B.A. Bluhm & R. Gradinger, *Regional variability in food availability for Arctic marine mammals*, 18 ECOLOGICAL APPLICATIONS S77, S83 (2008).

[83] *Id.* at S84.

[84] WORLD WILDLIFE FUND INT'L, *supra* note 61, at 19-20.

[85] *Id.* at 18.

[86] UNITED NATIONS ENVIRONMENTAL PROGRAMME, CLIMATE CHANGE 2009 SCIENCE COMPENDIUM 19 (Catherine McMullen ed., 2009). The disappearance of the Arctic ice cap during the sunlit period of the year would radically reduce the local albedo and cause an annually averaged 19.7 Wm^{-2} increase in absorbed solar flux at the Arctic Ocean surface, or equivalently an annually averaged 0.55 Wm^{-2} increase on the planetary scale. C. Matsoukas et al., *The Effect of Arctic Sea-Ice Extent of the Absorbed (Net) Solar Flux at the Surface, Based on ISCCP-D2 Cloud Data for 1983-2007*, 10 ATMOSPHERIC CHEMISTRY & PHYSICS 777,777 (2010).

[87] UNITED NATIONS ENVIRONMENTAL PROGRAMME, *supra* note 86, at 19.

[88] *Id.*

[89] WORLD WILDLIFE FUND INT'L, *supra* note 61, at 23.

2. Glaciers

The World Glacier Monitoring Service defines a glacier as "a mass of surface-ice on land which flows downhill under gravity and is constrained by internal stress and friction at the base and sides."[90] Glaciers and ice caps cover 10% of the Earth's surface and provide about 75% of the world's fresh water.[91] Glaciers in the U.S. are located in Alaska and the continental U.S. from the Rockies westward. Nine western states of the contiguous U.S. have glaciers: Washington, California, Oregon, Montana, Wyoming, Colorado, Idaho, Utah, and Nevada.[92] The glaciers of the continental U.S. have a total area of approximately 580 sq. km[93] and constitute 7% of world glacier area.[94] Washington State accounts for approximately 75% of U.S. glacial extent outside of Alaska.[95] Alaska contains approximately 11% of world glacier area.[96] Like sea ice, the Earth's glaciers as a whole are exhibiting rapid recession.[97] For example, the number of glaciers at Glacier National Park has dropped from 150 to 26 since 1850, with some projections suggesting that if current trends in the rate of melting continue, the remaining glaciers will disappear within the next 25 to 30 years.[98]

America's glaciers are afforded protection under the Clean Water Act because they feed traditional navigable waters and because glaciers meet the "significant nexus" test set forth by Justice Kennedy in *Rapanos v. United States*, 547 U.S. 715 (2006).

The "Clean Water Act is concerned with the pollution of tributaries as well as with the pollution of navigable streams, and 'it is incontestable that substantial pollution of one not only may but very probably will affect the other.'"[99] Thus, Clean Water Act jurisdiction extends to non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally.[100] A non-navigable tributary of a traditional navigable water is a

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[90] World Glacier Monitoring Service, *Global Glacier Changes: Facts and Figures* at 10 (2009).

[91] P. Jansson et al., *The Concept of Glacier Storage: a Review.* 282 J. HYDROLOGY 116, 117 (2003).

[92] Listed in order of glacier extent. R.M. Krimmel, *Glaciers of the Western United States, in* SATELLITE IMAGE ATLAS OF GLACIERS OF THE WORLD 329, Table 1 (J. Williams & J. Ferrigno, eds., 2002).

[93] *Id.* at 329.

[94] R.G. Barry, *The Status of Research on Glaciers and Global Glacier Recession: A Review*, 30 PROGRESS IN PHYSICAL GEOGRAPHY 285, 286 (2006).

[95] Krimmel, *supra* note 92 at 343, *see* Table 1 for individual states.

[96] Barry, *supra* note 94 at 286.

[97] P. Lemke et al., *Chapter 4, Observations: Changes in Snow, Ice and Frozen Ground in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 356 (S. Solomon et al. eds., 2007).

[98] GOVERNMENT ACCOUNTABILITY OFFICE, CLIMATE CHANGE: AGENCIES SHOULD DEVELOP GUIDANCE FOR ADDRESSING THE EFFECTS ON FEDERAL LAND AND WATER RESOURCES 18 (Aug. 2007), *available at*: http://www.gao.gov/news.items/d07863.pdf.

[99] *Headwaters, Inc. v. Talent Irrigation Dist.*, 243 F.3d 526, 534 (9th Cir. 2001) (citation omitted).

[100] EPA & Army Corps of Engineers, *supra* note 68, at 6; *see also United States v. TGR Corp.*, 171 F.3d 762, 764 (2d Cir. 1999) (non-navigable tributaries flowing into navigable streams are "waters of the United States"); *Quivira Mining Co v. EPA*, 765 F.2d 126, 130 (10th Cir. 1985) (creeks and arroyos connected to streams during intense rainfall are "waters of the United States"); *United States v. Texas Pipe Line Co.*, 611

non-navigable water body whose waters flow into a traditional navigable water either directly or indirectly by means of other tributaries.[101] Glaciers meet this definition because their waters flow into traditional navigable waters such as rivers and oceans. Indeed, due to their many important ecological functions, glaciers are considered "part of the fresh waters ecosystem."[102]

Glacial runoff comes from a variety of sources such as surface melting, melting by geothermal heat, precipitation that falls on glaciers, and pressure melting.[103] Kryal streams, which are fed directly by glacial melt, are one of the main types of alpine stream flow contributing to downstream waters.[104] Indeed, glaciers significantly influence most of Alaska's major rivers, even though glaciers cover just 5% of the state.[105] Similarly, most of the water flowing into the Gulf of Alaska from the Susitna River comes from mountain glaciers.[106] Glaciers in the continental United States are also a water source for downstream rivers. For example, Triple Divide Peak in Glacier National Park contributes to three major river systems: the Columbia, Saskatchewan, and Missouri.[107] Similarly, glaciers on Mt. Rainier feed five major rivers: Nisqually, Cowlitz, White, Carbon, and Puyallup.[108]

Glaciers are also water bodies with continuous seasonal flow. Joint EPA/Army Corps of Engineer guidance provides that a water body is seasonal if it exists "typically three months" of the year.[109] Glaciers at all latitudes exhibit annual ablation (melt/loss of snow and ice) during late spring and summer, a span of at least three months.[110] At low latitudes, ablation occurs year-round.[111]

Protection of glaciers under the Clean Water Act is warranted on the alternative grounds that glaciers meet the jurisdictional test articulated by Justice Kennedy in *Rapanos v. United States*, 547 U.S. 715 (2006) for what constitutes a regulable water

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F.2d 345, 347 (10th Cir. 1979) (oil spill into tributary involved "waters of the United States," even though no evidence tributary was discharging into traditional navigable waters at time of spill).

[101] EPA & Army Corps of Engineers, *supra* note 68, at 6.

[102] GOVERNMENT ACCOUNTABILITY OFFICE, *supra* note 98, at 159.

[103] Randy Bowersox, *Hydrology of a Glacial Dominated System, Copper River, Alaska, in* GLACIAL AND PERIGLACIAL PROCESSES AS HYDROGEOMORPHIC AND ECOLOGICAL DRIVERS IN HIGH-LATITUDE WATERSHEDS 2 (J. Mount et al. eds., 2002).

[104] F.R. Hauer et al., *Pattern and Process in Northern Rocky Mountain Headwaters: Ecological Linkages in the Headwaters of the Crown of the Continent,* 43 J. AM. WATER RESOURCES ASS'N 104, 107 (2007).

[105] Alaska Department of Natural Resources, Division of Mining, Land & Water, Alaska Hydrologic Survey, http://dnr.alaska.gov/mlw/water/hydro/index.htm (last visited January 26, 2010).

[106] NASA Earth Observatory, Alaska Glaciers and Rivers: Image of the Day, http://earthobservatory.nasa.gov/IOTD/view.php?id=8117 (last visited January 27, 2010).

[107] F.R. Hauer et al., *supra* note 104, at 105.

[108] *See* National Park Service, *The Little Tahoma News*, http://www.nps.gov/archive/mora/kids/student5.htm (last visited Jan. 28, 2010).

[109] EPA & Army Corps of Engineers, *supra* note 68, at 7.

[110] P. Lemke et al., *Chapter 4, Observations: Changes in Snow, Ice and Frozen Ground in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 356 (S. Solomon et al. eds., Cambridge Univ. Press 2007).

[111] *Id.*

under the Act.[112] In *Rapanos,* Justice Kennedy held that Clean Water Act jurisdiction extends to waters or wetlands that "possess a 'significant nexus' to waters that are or were navigable in fact or that could reasonably be so made."[113] A significant nexus exists if "either alone or in combination with similarly situated lands in the region, [they] significantly affect the chemical, physical, and biological integrity of other covered waters more readily understood as 'navigable.'"[114]

Glaciers meet the significant nexus test because they significantly affect the chemical, physical, and biological integrity of downstream waters. Chemical impacts of glaciers to downstream waters include water dilution and increased pollutant loads. For instance, meltwater contributions from glaciers tend to be relatively dilute with low nutrient content, but with glacier retreat, downstream waters will have greater exposure to soils that could contribute more ions such as phosphorus and nitrogen.[115] Because glaciers also concentrate volatile organic compounds transported from agricultural and industrial activity, increased melt rates will result in greater amounts of these compounds being deposited in downstream waters.[116] The same has been observed for organochlorides.[117] Glacial retreat can result in additional dangers to water quality, including increased suspended sediment load and increased water temperature.[118] Changes in water temperature can result in thermal stratification and reduced nutrient cycling.[119]

The physical integrity of downstream waters in a large number of water basins is dependent on glacial meltwaters. One of the main services provided by glaciers is water storage. Water storage occurs both as frozen water in the form of ice as well as precipitation stored in glacial aquifers.[120] In many areas summer melt provides a regulating influence to maintain stream flows during the dry season.[121] The importance

[112] *Rapanos* was decided in a fractured 4-1-4 decision, with Justice Kennedy's concurrence providing the deciding vote. In interpreting *Rapanos*, circuit courts have determined that either: (1) Justice Kennedy's concurrence provides the controlling rule of law; or (2) jurisdictional requirements are met if either the test articulated by Justice Kennedy or the plurality in *Rapanos* is met. Under either interpretation, regulatory jurisdiction would be established if Justice Kennedy's test is satisfied. *See, e.g., United States. v. Gerke Excavating, Inc.,* 464 F.3d 723, 724 (7th Cir. 2006) (Kennedy concurrence controlling); *Northern California River Watch v. City of Healdsburg*, 496 F.3d 993, 999-1000 (9th Cir. 2006) (same); *United States v. Johnson,* 467 F.3d 56, 66 (1st Cir. 2006) ("federal government can establish jurisdiction over the target sites if it can meet either the plurality's or Justice Kennedy's standard").

[113] *Rapanos v. United States,* 547 U.S. 715, 759 (2006).

[114] *Id.* at 780.

[115] R.D. Moore et al., *Glacier Change in Western North America: Influences on Hydrology, Geomorphic Hazards and Water Quality.* 23 HYDROLOGICAL PROCESSES 42, 53 (2009); F.R. Hauer et al., *supra* note 104, at 107.

[116] R.D. Moore et al., *supra* note 115, at 53.

[117] C. Rosenzweig et al., *Chapter 1. Assessment of Observed Changes and Responses in Natural and Managed Systems in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 91 (M.L. Parry et al. eds., Cambridge Univ. Press 2007).

[118] R.D. Moore et al., *supra* note 115, at 53-55.

[119] C. Rosenzweig et al., *supra* note 117, at 91.

[120] P. Jansson et al., *supra* note 91, at 119-22.

[121] R.D. Moore et al., *supra* note 115, at 48.

of glacial water sources operates at multi-year, seasonal, and daily time scales.[122] Non-ice sheet glaciers are also significant because they can change extent much more rapidly than ice sheets, and thus are the current greatest contributor to increases in sea level.[123] In fact, it is estimated that the world's non-ice sheet glaciers would cause a 0.65 ± 0.16 m rise in sea level if they melted completely.[124] Glacial water storage and release also has important implications for hydroelectric power plants, irrigation, consumptive use, and local ecosystems.[125] Decreasing summer runoff will result in lower water levels in lakes and rivers, which in turn will cause re-suspension of sediment and free harmful compounds within the sediment.[126] Destabilization due to glacial retreat can also increase the risk of "geomorphic hazards" such as floods, avalanches, and debris flow.[127]

Perhaps most important are the ecosystem services provided by glacier water systems. The detrimental chemical and physical effects of glacial retreat can significantly impact the biological integrity of downstream ecosystems. For instance, freshwater temperature is extremely important for salmon spawning.[128] The increased temperature in late summer due to glacial recession would represent yet another stress to species that are already imperiled. On the other hand, abundance of macroinvertebrates is likely to increase with reduced meltwater contributions.[129] This increase in abundance at a given site, however, will likely be accompanied by a *decrease* in biodiversity between streams or within a region.[130] This is due to the fact that streams will become more homogeneous in their characteristics and thus species highly-adapted for conditions that include significant meltwater contributions will be extirpated.[131] These vulnerable species will be lost as the balance of meltwater and other water sources changes for a given stream.

Specialized alpine ecosystems are highly adapted to the temperature and flow conditions that currently exist near glaciers. Due to their highly adapted nature, these ecosystems are vulnerable to small changes and thus would likely be unable to survive a transition to a different stream system.[132] Glaciers also host microbial ecosystems within the ice. These ecosystems are sensitive to heat changes on varying time scales.[133] One

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[122] P. Jansson et al., *supra* note 91, at 117-19, 123.
[123] *Id.* at 118.
[124] M.B. Dyurgerov & M.F. Meier, *Glaciers and the Changing Earth System: A 2004 Snapshot* at 7, Occasional Paper 58 (2005): Institute of Arctic and Alpine Research, University of Colorado.
[125] R.D. Moore et al., *Glacier Change in Western North America: Influences on Hydrology, Geomorphic Hazards and Water Quality.* 23 HYDROLOGICAL PROCESSES 42 (2009).
[126] Z.W. Kundzewicz et al, *Chapter 3, Freshwater Resources and their Management in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 188 (M.L. Parry et al. eds., Cambridge Univ. Press 2007).
[127] R.D. Moore et al., *supra* note 115, at 50.
[128] *Id.* at 56.
[129] L.E. Brown et al., *Vulnerability of Alpine Stream Biodiversity to Shrinking Glaciers and Snowpacks*, 13 Global Change Biology 958, 963 (2007).
[130] *Id.*
[131] *Id.*
[132] F.R. Hauer et al., *supra* note 104, at 108.
[133] *See* A. Hodson et al., *Glacial Ecosystems*, 78 ECOLOGICAL MONOGRAPHS 41 (2008).

study suggests that globally the microoganisms living in cryoconite holes on the surface of glaciers may fix as much as 64 Gg of carbon per year.[134] Thus, loss of glacial extent would reduce this potential for carbon sequestration and further exacerbate global warming.

For glaciers that are part of coastal watersheds, such as those surrounding the Gulf of Alaska, glaciers are an important source of ancient and labile organic matter for the marine environment.[135] Changes in glacier volume due to climactic factors could therefore alter the age, quantity and reactivity of dissolved organic matter entering coastal oceans.[136]

Thus, not only are glaciers directly connected to traditional navigable waters, but they also significantly affect the chemical, physical, and biological integrity of other covered waters more readily understood as 'navigable.' Accordingly, EPA has authority to set water quality criteria for glaciers under the Clean Water Act.

B. Atmospheric Depositions of Black Carbon onto Waters of the United States are Subject to Clean Water Act Authority

Air pollution often has serious adverse impacts on water quality. As recognized by EPA, "[a]irborne pollutants from human and natural sources can deposit back onto land and water bodies, sometimes at great distances from the source, and can be an important contributor to declining water quality."[137] Accordingly, pollutants that are emitted into the atmosphere but ultimately impact water quality are regulated under the Clean Water Act. For example, mercury is an airborne pollutant that is regulated under Section 303(d) of the Act.[138] Like black carbon, impairment of a waterbody from mercury is predominately a result of atmospheric deposition from a "combination of local, regional and international sources."[139] Therefore, the fact that black carbon impairs sea ice and glaciers as a result of atmospheric deposition is not an impediment to regulation under the Clean Water Act.

VI. REQUESTED RULEMAKING

EPA has the duty under the Clean Water Act to protect and maintain the water quality of our nation. Black carbon pollution jeopardizes the chemical, physical and biological integrity of sea ice, glaciers and the ecosystems they support. This fundamental threat to the continued existence of sea ice and glaciers must be addressed

[134] A.M. Anesio et al., *High Microbial Activity on Glaciers: Importance to the Global Carbon Cycle*, 15 GLOBAL CHANGE BIOLOGY 955 (2009).

[135] Eran Hood et al., *Glaciers as a Source of Ancient and Labile Organic Matter to the Marine Environment*, 462 NATURE 1044 (2009).

[136] *Id.*

[137] EPA, Water: Wetlands, Oceans, and Watersheds, *Air Pollution and Water Quality*, http://www.epa.gov/owow/airdeposition/index.html (last visited Jan. 11, 2010).

[138] E.P.A., Total Maximum Daily Loads (TMDLs) and Mercury, http://www.epa.gov/owow/tmdl/mercury/ (last visited December 28, 2009).

[139] *Id.*

under the Clean Water Act. Addressing the adverse effects of black carbon deposition begins with accurate, science-based water quality criteria. EPA's adoption of water quality criteria triggers the adoption of water quality standards by the states, which are the basis for the required development of implementation plans designed to meet these standards. Establishing water quality criteria for black carbon under Section 304 of the Act is therefore an important first step toward the restoration of sea ice and glaciers.

A. EPA Must Develop and Publish Water Quality Criteria for Black Carbon Deposition on Sea Ice and Glaciers

The Center for Biological Diversity formally requests that EPA initiate a rulemaking pursuant to the Clean Water Act, 33 U.S.C. § 1314(a)(1), to address water quality threats posed by black carbon to sea ice and glaciers. This Petition for rulemaking specifically requests that EPA adopt a criterion for black carbon stating:

Black carbon concentrations on sea ice and glaciers should not deviate measurably from preindustrial levels.

Section 304 of the Clean Water Act requires EPA to publish and revise water quality criteria "from time to time" to "accurately reflect the latest scientific knowledge."[140] As presented herein, there is extensive new information concerning the adverse effects of black carbon deposition on sea ice and glaciers. Pursuant to its duties under the Clean Water Act, EPA must consider this new information and publish national water quality criteria for black carbon.

Water quality criteria must reflect the latest scientific knowledge related to the effects of pollutants "on health and welfare, including, but not limited to, plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, esthetics, and recreation."[141] The criteria must also reflect the latest scientific knowledge "on the concentration and dispersal of pollutants, or their byproducts, through biological, physical, and chemical processes; and . . . on the effects of pollutants on biological community diversity, productivity, and stability."[142] According to EPA, a "water quality criterion is a level of a pollutant or other measurable substance in water that, when met, will protect aquatic life and/or human health."[143] Water quality criteria developed under Section 304(a) must be "based solely on data and scientific judgments . . . . [t]hey do not consider economic impacts or the technological feasibility of meeting the criteria."[144]

Petitioner requests a new criterion for concentrations of black carbon on sea ice and glaciers that allows *no measurable deviation* from preindustrial levels. The latest scientific information indicates that, in today's warmer climate, even "very small

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[140] Clean Water Act § 304(a)(1), 33 U.S.C. § 1314(a)(1) (2006).
[141] *Id.*
[142] *Id.*
[143] *Final Aquatic Life Ambient Water Quality Criteria for Diazinon,* 71 Fed. Reg. 9336 (Feb. 23, 2006).
[144] *Notice of Availability of Final Aquatic Life Criteria Document for Tributyltin,* 69 Fed. Reg. 342, 343 (Jan. 5, 2004).

concentrations of black carbon impurities (~10 ppb) are triggering astonishingly large ice-albedo warming."[145] Pristine Antarctic regions, which could serve as a basis from which to establish preindustrial levels, have been found to contain black carbon concentrations of 0.1-0.3 ppbw.[146] Even seemingly minor increases from these levels have been found to accelerate melt. For example, black carbon amounts as low as 2 ppbw on Greenland may affect visible albedo as much as 1%, which is a measurable contribution compared with the balance of fluxes that determine ice sheet mass balance.[147] Black carbon measurements in the Alps revealed concentrations as large as 100 ppbw, enough to reduce the visible albedo by approximately 10% and double the absorption of sunlight.[148]

Water quality criteria established under Section 304 serve an important regulatory function that will help save sea ice, glaciers, and the ecosystems they support. Under the Clean Water Act, states are required to set water quality standards for *all* waters within their boundaries regardless of the sources of pollution entering the waters.[149] EPA's adoption of water quality criteria compel states to adopt this standard for their own waters, or an alternative standard subject to EPA approval and consistent with the Act.[150] Once adopted, the standards are the basis for developing regulatory controls on the discharge or release of pollutants.[151] Specifically, Section 303(d) requires states to identify waters for which existing controls are inadequate to ensure compliance with any water quality standards applicable to those waters and to establish a "total maximum daily load" (TMDL) at the level necessary to implement the applicable water standards.[152] TMDLs limit the total amount of a pollutant that can be loaded into the applicable water from all combined sources and serve as a link in the implementation chain that includes federally-regulated point source controls, state or local plans for point and nonpoint source pollution reduction, and assessment of the impact of such measures on water quality, all to the end of attaining water quality goals for the nation's waters.[153] Under Section 303(e) of the Act, states are required to have a continuing planning process approved by EPA that provides, among other things, adequate implementation, including schedules of compliance, to meet its water quality standards.[154] Accordingly, the development of water quality criteria by EPA is the first step toward measures to limit black carbon pollution on sea ice and glaciers.

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[145] *Hearing*, *supra* note 16, at 74 (statement of Charles Zender, Associate Professor, University of California at Irvine).
[146] Hansen & Nazarenko, *supra* note 17, at 424.
[147] *Id.* at 428.
[148] *Id.* at 427.
[149] *Pronsolino v. Nastri*, 291 F.3d 1123, 1127 (9th Cir. 2002).
[150] *See, e.g.*, EPA, *National Recommended Water Quality Criteria*, Part IV, 63 Fed. Reg. 67548 (Dec. 7, 1998); Clean Water Act § 303(b), (c); 33 U.S.C. § 1313(b), (c).
[151] Clean Water Act § 303, 33 U.S.C. § 1313 (2006).
[152] Clean Water Act § 303(d), 33 U.S.C. § 1313(d) (2006).
[153] Clean Water Act § 303(d)(1)(C), 33 U.S.C. § 1313(d)(1)(C) (2006); *Pronsolino*, 291 F.3d at 1129.
[154] Clean Water Act § 303(e), 33 U.S.C. § 1313(e) (2006).

B. EPA Must Develop and Publish Information on the Factors Necessary to Maintain the Integrity of Sea Ice and Glaciers

Section 304(a)(2) of the Clean Water Act requires that EPA publish and "from time to time thereafter revise" information on: (A) the factors necessary to restore and maintain the chemical, physical, and biological integrity of all of the nations waters; (B) the factors necessary for the protection and propagation of fish, shellfish, and wildlife; (C) measurement and classification of water quality; and (D) identification of pollutants suitable for measuring maximum daily loads related to water quality.[155] States use this information to adequately evaluate the Section 304(a)(1) criteria and its applicability to the state's waters. This information also plays a valuable role in the education of state personnel and the management of state water resources. States can better apply the necessary controls on black carbon emissions to address the loss of sea ice and glaciers if EPA first provides information under Section 304(a)(2)(A).

Pursuant to Section 304(a)(2), Petitioner requests that EPA publish information discussing the factors necessary to maintain the integrity of sea ice and glaciers. It may be helpful to begin this discussion with information on the current and projected losses of sea ice and glaciers and the present and future impacts resulting from this loss. The primary contributors to sea ice and glacier depletion, specifically increased atmospheric concentrations of greenhouse gases and black carbon can then be discussed. As set forth in this Petition, the scientific literature provides extensive data on the role of black carbon in accelerating the loss of sea ice and glaciers.

Because local sources of black carbon emissions are thought to have a disproportionate effect on sea ice and glaciers, it would be helpful for EPA to publish information on sources of black carbon emissions in Alaska and its surrounding waters as well as sources of emissions proximate to glaciers. Once these sources are identified, EPA can provide information on potential measures to reduce emissions from these sources.

The role of black carbon in an overall strategy to save Arctic sea ice and glaciers should also be discussed. Because black carbon has a lifespan in the range of days to weeks, controls on black carbon can provide an immediate climate benefit and an important window of opportunity to stem the loss of glaciers and sea ice until atmospheric concentrations of much longer-lived greenhouse gases are reduced to safe levels.

VII. SEVERABILITY

The provisions of this Petition are severable. If any provision of this Petition is found to be invalid or unenforceable, the invalidity or lack of legal obligation shall not affect other provisions of the Petition.

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[155] Clean Water Act § 303(a)(2), 33 U.S.C. § 1314(a)(2) (2006).

VIII. CONCLUSION

Arctic sea ice and glaciers are disappearing at a rate even more rapid than predicted only a few years ago. Under the Clean Water Act, EPA is directed to protect all of the nation's waters from pollution. EPA can squarely address the contribution of black carbon to sea ice and glacier decline under its Clean Water Act authority.

To adequately address the problem of sea ice and glacier loss due to black carbon, EPA must promulgate new water quality criteria under Clean Water Act Section 304(a)(1) to accurately reflect the latest scientific knowledge regarding the adverse impacts of black carbon deposition.

EPA is also requested to publish information pursuant to Section 304(a)(2) to provide much needed information on black carbon to the states and to serve as the basis for a comprehensive approach to reducing black carbon emissions.

Respectfully submitted,

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